

## SECTION 662

### ROADWAY LIGHTING

#### 662.1-DESCRIPTION:

This item shall consist of manufacturing, furnishing and installation of a lighting system in accordance with the requirements of the Plans and of these Specifications. All details not specified or not shown on the Plans shall conform to the details and requirements set forth in the following specifications and publications:

*Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, latest issue, American Association of State Highway and Transportation Officials (AASHTO).

*National Electrical Code*

*American National Standards Institute*

In addition to the Plans, these Specifications and the above noted publications, any applicable local code shall apply.

#### 662.2-MATERIALS:

Materials furnished by the Contractor shall be of new stock, shall be the product of the reputable manufacturers of lighting equipment, shall conform to Division of Highways' Specifications and shall meet the approval of the Engineer.

All materials shall conform to Division 700 of the Standard Specifications and specifically as follows, unless otherwise modified on the Plans. Reference specifications for materials shall be understood to be the latest available specification and revision at the time of award of the contract.

**662.2.1-Concrete:** All concrete shall conform to Standard Specifications, Section 601, Types B or K (Bridge Superstructure).

**662.2.2-Reinforcing Steel Bars:** Reinforcing steel bars shall conform to the applicable requirements of Section 602 of the Standard Specifications.

**662.2.3-Electrical Conduit:** Electrical Conduit shall meet the requirements of Section 715.42.10.

**662.2.3.1-Type R (Rigid Steel Conduit):** Type R (Rigid Steel Conduit) shall meet the requirements of Section 715.42.10.1.

**662.2.3.2-Type F (Flexible, Liquid-Tight Conduit):** Type F (Flexible, Liquid-Tight Conduit) shall meet the requirements of Section 715.42.10.2.

**662.2.3.3-Type P (Polyvinyl Chloride Conduit):** Type P (Polyvinyl Chloride Conduit) shall meet the requirements of Section 715.42.10.3.

**662.2.4-Junction Boxes:** The following Specifications shall set forth minimum design requirements for junction boxes for lighting cable and other electrical wiring. The type shall be noted on the Plans.

Junction boxes as shown on the Plans shall be installed where indicated. The Contractor may, with the approval of the Engineer and at his own expense, install additional junction boxes to facilitate the work of installing conduit and pulling cable.

**662.2.4.1-Types A, B and C:** Types A, B, and C shall meet the requirements of Section 715.42.11.4.

**662.2.4.2-Type L (Light Duty):** Type L (Light Duty) shall meet the requirements of Section 715.42.11.1.

**662.2.4.3-Type H (Heavy Duty):** Type H (Heavy Duty) shall meet the requirements of Section 715.42.11.2.

**662.2.5-Manholes:** Manholes shall be constructed to the dimensions shown in the Plans. Unless otherwise noted on the Plans, all units shall be completely equipped with the necessary cable racks, rack insulators, frames and covers, and all other appurtenances detailed on the Plans and approved by the Engineer.

Concrete manholes shall be monolithic construction and maybe either precast or cast in place.

**662.2.5.1-Cable Rack:** The cable rack assembly shall be a combination of Line Material Company Catalog Nos. DU17B2, DU581 or DU582, DE11U1, and WDU4M1, Joslyn Catalog Nos. J5124, J5131 or J5132, and J5122, or equal.

**662.2.5.2-Pulling Iron:** The pulling iron shall be Line Material Company Catalog # DU2T2, Joslyn Catalog # J8119, or equal.

**662.2.5.3-Ground Connector:** The ground connector shall be Burndy Company Type KC22B1, Dossert #DGN-5, or equal.

**662.2.6-Ground Rods:** Ground rods shall be copperclad steel,  $\frac{3}{4}$  inches (19 mm) in diameter with a minimum length as noted on the plans and shall be one piece. Sectional or segmented ground rods are not permitted. The ground rods shall be complete with ground clamp and square head bolt.

**662.2.7-Roadway Luminaires:** All castings shall be smooth, clean and free from cracks, blisters, pockets, voids, rough or chipped spots, or other similar defects.

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The luminaire shall have a slipfitter capable of accepting mounting tenons made from 2 in. (50 mm) pipe and adjustable plus or minus three degrees about the tenon axis. No additional parts shall be required to accomplish the adjustment.

The luminaire shall have a terminal block prewired into the electrical system so that only two connections from the # 10 AWG tap wires need be made.

The ballast compartment shall be immediately accessible via a separate cover door such that the lamp area need not be opened to service the ballast.

The luminaire shall have a removable, parabolically formed aluminum reflector system with a finish as recommended by the manufacturer.

The luminaire shall have a porcelain mogul base socket capable of being adjusted along both the longitudinal and vertical axis of the lamp proper. A lamp grip shall also be provided at the socket.

The reflector-refractor chamber shall be gasketed with synthetic rubber or dacron felt gasket and filtered, when available for fixture type, with a replaceable activated charcoal or fiberglass filter such that the chamber shall be waterproof and dust-tight.

The refractor lens shall be cast for borosilicate glass or, when specified on the Plans, vandal resistant polycarbonate resin. It shall be temperature, shock and ultraviolet resistant and shall be free from visible cracks, blisters, bubbles, flashed or sharp flanges, or other similar defects.

The optical system shall produce the IES standard distribution patterns as specified and shall be capable of accepting internal, external, or internally molded--in shielding.

When so designated on the Plans, the luminaire shall be of a total cut-off type design, specially fabricated to recess the lamp and having a flat lens.

**662.2.7.1-Luminaire Wattages:** The luminaires shall be manufactured by General Electric, McGraw-Edison, Sylvania, American Electric or shall be approved equal.

The luminaires shall be designed to accommodate the appropriate lamps as called for on the Plans and Listed in [662.2.9](#).

**662.2.7.2-Luminaire Ballasts:** Luminaire ballasts shall be designed to rapidly restrike the lamp in the event of an outage and shall start the lamp at a minimum temperature of  $-20^{\circ}\text{F}$  ( $-29^{\circ}\text{C}$ ).

The ballasts for high pressure sodium lamps shall be of the high power-factor type (93 to 99 percent), similar to constant wattage type, and shall be rated to the circuit voltage and lamp wattage specified. The ballasts shall deliver rated lamp current at line-voltage variation of plus or minus 10 percent, with no more than plus or minus 5 percent of lamp wattage regulation. Starting aids shall be of the encapsulated type.

**662.2.7.3-Area Luminaires:** The luminaire requirements for "area" and "walkway" lighting shall be as called for in the Plans and in accordance with

the latest edition of Special Provisions, Section 662, "SAFETY REST AREA LIGHTING" Subsection 662.11, Area Lighting Luminaires. Other portions of 662.2.7 above named shall not necessarily apply.

When incorporated as part of a Roadway Lighting project, the "area" or "walkway" type luminaire shall be Post Top Mounted on Type VII aluminum poles in accordance with 662.2.13.3. In this case, the "area" or "walkway" type luminaire shall be paid for under Item 662070-\*, "LUMINAIRES", per each.

**662.2.8-Underpass Luminaires:** The luminaire housing shall be die-cast aluminum and shall be gasketed to form a weatherproof and dusttight unit. All castings shall be smooth and clean and free from cracks, blisters, pockets, voids, rough or chipped spots, or other similar defects.

The assembly shall be prewired. The refractor shall meet the requirements set forth in 662.2.7, and the refractor holder shall be hinged to the housing and secured by stainless steel latches and safety chain. The reflector shall be anodized finished polished aluminum. The socket shall be an adjustable porcelain mogul-base type with lamp grip. The ballast shall meet the requirement set forth in 662.2.7.2.

The luminaire shall be manufactured by Guth, General Electric, Holophane or shall be approved equal. The luminaire shall be designed to accommodate the appropriate lamp as called for on the Plans and listed in 662.2.9.

**662.2.9-Lamps:** The high pressure sodium lamps shall be as manufactured by General Electric, Crouse-Hinds, Hollophane or approved equal. Any lamp shall be of the manufacturer's latest specification and shall meet the following minimum characteristics:

For the following chart: Life = minimum rated life hours; Initial Lumens = minimum initial lumens in horizontal position; Relamping Factor = estimated lamp lumen depreciation at the end of relamping period.

TYPE/WATTS	LIFE-HOURS	INITIAL LUMENS	RELAMPING FACTOR
H.P.S./50-clear	24,000	4,000	0.73
H.P.S./70-clear	24,000	5,800	0.73
H.P.S./100-clear	24,000	9,500	0.73
H.P.S./150-clear	24,000	16,000	0.73
H.P.S./250-clear	24,000	30,000	0.73
H.P.S./400-clear	24,000	50,000	0.73
H.P.S./1000-clear	24,000	140,000	0.73

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**662.2.10-Wire and Cable:** All wire and cable for feeder and branch circuits shall conform to the requirements of the current edition of the National Electric Code and shall meet all relevant ASTM Specifications. Conductors shall be coated softdrawn copper, unless otherwise noted on the Plans or in these Specifications. Insulation shall be type THWN or XHHW. Cable shall be UL approved.

Conductor sizes shall be standard American Wire Gauge sizes and shall be as noted on the Plans. All conductors shall be stranded. Stranded wire shall have a minimum of 19 strands.

The 15 KV wire and cable shall be single conductor G.E. Catalog # S1-58224, Anaconda AP-15315, Hatfield, Okonite, or approved equal. This cable shall have an approved stress cone at the terminating point.

All wire and cable shall have the size, voltage rating, type of insulation and manufacturer's name permanently marked on the outer covering at regular intervals. The manufacturer shall furnish to the Engineer and the Contractor all splicing or terminating information necessary for proper installation of the cable.

Color coding for the roadway lighting cables shall be permanent solid color as follows:

Single Phase		Three Phase	
Leg A	Black	Phase A	Black
Leg B	Red	Phase B	Red
Neutral	White or Gray	Phase C	Blue
Equipment Ground	Green	Equipment Ground	Green

Color coding of electrical conductors by use of phase tape or field paint is not acceptable. Conductors shall be manufacturer-colored, striped or ridge-marked.

Bare ground conductors shall be softdrawn copper.

**662.2.10.1-Connectors:** Cable connections in lighting support bases (except for Type IV and Type X) shall be made by means of connector kits, fused or nonfused, as indicated on the Plans. Underpass luminaires will be fused individually in the nearest accessible junction box.

Fused "Y" connectors shall be composed of a "Y" line side housing assembled with a load side and fuse terminal housing. The housings shall be formed from water-resistant synthetic rubber. Each housing shall provide a watertight seal around the cables and when fully assembled, shall form a watertight assembly. The cable size shall determine the connector size. Fuses shall be sized in accordance with nominally rated loads.

The line side housing shall contain a wye-tap having crimp or screwlug

type connectors for the line wires and spring-loaded fuse contacts. The assembly shall have 90 percent minimum conductivity.

The load side housing shall contain a crimp-type connector for the load wire and spring loaded fused contacts. The assembly shall have 90 percent minimum conductivity.

When a load-side wire is pulled or jerked, the load-side housing and assembly, including the fuse and any protruding contacts, shall separate from the line-side housing and assembly, leaving no exposed contacts in the line-side housing.

All wire to wire connections shall be made by the use of connector kits. Unfused connectors shall be used on all neutral wire. All wire to wire connections must be made in accessible locations with workable wire slack as required. Accessible locations include manholes, junction boxes and bases.

**662.2.10.1.1-Splices:** In special cases, such as conductor sizes in excess of #1/0 AWG and with written approval of the Engineer, wire splicing may be permitted. As with connector kits, splicing shall be done only in accessible, workable areas. Electrical splicing, when approved, shall be used at specific locations only and the number of splices shall be kept at a minimum.

When connector kits are not used, the following splicing method shall be used. Splices on all wire and in all boxes shall be made mechanically and electrically secure by means of an approved split bolt connector only. It shall then be wrapped with layers of insulating tape and in opposite directions. Over the insulating tape, two layers of friction tape shall be applied, followed by several layers of jacket tape, two final layers of friction tape and two coats of an electrical waterproofing paint. The insulating tape shall be wrapped to a wall thickness equal to 12 times the wall thickness of the cable insulation. Similarly, the jacket tape shall be wrapped to a thickness equal to 12 times the thickness of the cable jacket.

**662.2.10.2-Aerial Cable:** Aerial cable shall be either aluminum NSD or lashed galvanized messenger construction. Cable assembly shall be self-supporting.

**662.2.10.2.1-Conductors:** Insulated conductors shall conform to the requirements noted in 662.2.10. Insulation shall be XLP.

**662.2.10.2.2-Messenger Cable:** Messenger for the aluminum N-SD cable shall be bare, stranded, steel reinforced aluminum.

Messenger for the lashed galvanized cable shall be extra high strength galvanized steel wire with a breaking strength of not less than 11,000lb (49 kN). Lashing shall be stainless steel, ANSI 300 series.

## **662.2.11-Cable-in-Duct:**

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**662.2.11.1-Description:** The work under this item covers the installation of a system as described in the Plans and Special Provisions suitable for an installation buried directly in the earth.

**662.2.11.2-Materials and Testing:** The materials furnished and the testing necessary shall be as prescribed in the Plans.

## **662.2.12-Service and Control Stations:**

**662.2.12.1-General:** The Contractor shall furnish and install service and control stations as noted on the Plans to serve the roadway lighting circuits. Service and control stations shall consist of cabinet (enclosure), all-weather padlock, control panel, conduit, cable, rock and earth excavation, backfill, concrete and steel reinforcement for the equipment pad, fencing and gate, transformer, grounding and all other incidentals for a complete and operable system as called for on the Plans.

Cabinets, electrical equipment, grounding and miscellaneous items shall conform to size, rating and description shown on the Plans and applicable NEMA and ANSI Standards as well as the usual practices of the local utility company and the National Electrical Code. Conductors shall be neatly arranged in a workmanlike manner and laced with nylon cable straps.

Cabinets (enclosures) shall be provided with nameplates and a wiring diagram of the circuits installed within the service and control station, sealed with a plastic cover and permanently attached to the inside of the door under a metal frame at a height of not less than one-half the door height.

Photoelectric controllers shall be the twistlock type, 120 volt, preset to "turn on" between 1.0 and 3.5 footcandles. "Turn off" shall be at least two times the "turn on" level; however, "turn off" must be greater than 3.0 and less than 15.0 footcandles. The unit shall meet all relevant NEMA Standards and shall be north oriented.

Transformers shall be built in accordance with the latest revision of the ANSI-NEMA standards for outdoor type distribution transformers, as manufactured by G.E., Westinghouse or shall be approved equal.

Two prints of shop drawings indicating the proposed dimensions and material specifications for the control center, cabinet (enclosure), and transformer, if required, shall be submitted for approval purposes within three weeks after the award of the Contract. These drawings will be reviewed by the Division at the earliest possible date and one print will be returned marked "Approved" or "Returned for Revisions as Noted." Eight sets of drawings shall then be submitted for final approval. Resubmission of drawings to obtain final approval by the Division shall not be considered as being just cause for delay in completion of any contract.

**662.2.12.2-Ground Mounted Cabinets:** The entire assembly shall meet the requirements of NEMA Type 4 Standards.

Framed overlapping doors shall be installed in the front of each cabinet for

access to the panel interior, and they shall be hung on a substantial set of stainless steel hinges. The doors shall be provided with three-point and two-point, vault-type latch and padlock lugs. The cover joints shall have returned lips and shall be provided with gaskets which shall prevent water from entering the panels. A rain shield shall be provided over the doors.

Mounting plates and channels shall be provided within the cabinet for installing contractors, panelboards, auxiliary transformers, etc. The wiring shall be neatly arranged, laced and securely fastened in an approved manner.

Chain link fences shall conform to the requirements of 712.8 of the Specifications and shall contain at least four signs (one per center of each of the four sides) with the legend 'DANGER-HIGH VOLTAGE.'

Rock and earth excavation shall be in accordance with 207 of the Specifications, as revised and amended.

Adequate stainless steel screens and louvers shall be provided for the ventilation of internal equipment.

**662.2.12.3-Pole Mounted Cabinets:** The lighting circuit protector and disconnect switch shall have a NEMA Type 4 enclosure with operator capable of being locked in either position. Disconnect switch and fuse, or circuit breaker shall be rated and furnished with fuse or breaker size as shown on the Plans.

The framework steel and hardware used in the cabinet shall be stainless steel.

**662.2.12.4-Service Poles:** Service points shown on the Plans are approximate only. Final location of service poles shall be determined in the field. Materials and costs for the connections to the service point will be paid for by the Contractor. The Contractor shall conform to utility company requirements for this item. The service pole grounding system shall be installed as part of the pole in accordance with the requirements of the local power company.

All wiring on the poles shall be installed in steel conduits of sizes as shown on the Plans and shall be securely fastened to the service pole with pipe straps at not over four-foot (1.2 m) maximum spacing. All pole line hardware used in the service poles and control stations shall be hot-dipped galvanized.

### **662.2.13-Lighting Supports:**

#### **662.2.13.1-Lighting Pole Type I, II and III-Steel:**

**662.2.13.1.1-General Description:** Each Lighting Pole, Type I, II and III shall consist of a pole shaft, removable pole top, luminaire support arm, base, support base (if required), anchor bolts, removable anchor bolt covers and any other accessories or hardware as required to make a complete installation as called for on the Plans or as directed by the Engineer. Spreads and mounting



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heights shall be as detailed on the Plans; tolerance for mounting heights shall be plus or minus 6 inches (150 mm). All wiring shall be concealed within the pole shaft and luminaire support arm.

Lighting Poles Type I, II and III shall be certified to equal or exceed the requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", based on at least 80 mph (129 km/hr) wind loads, a luminaire weight of 70 lb. (31.7 kg) and a luminaire projected area of 3.0 sq. feet (0.279).

The maximum allowable pole deflection from vertical at the top of the pole, due to the weight of the arm and luminaire, shall be two percent of the total shaft length. The pole deflection from vertical is defined as the horizontal distance between the pole top centerline when the pole alone is installed plumb and the pole top centerline after the arm and luminaire combination is installed on the previously plumb pole, the measurement to be made without additional shaft adjustment. The fabricator shall certify to the above and maintain results of computations or tests to document compliance, for each type of lighting pole supplied.

**662.2.13.1.2-Pole Shaft:** The pole shaft shall be an ASTM A 595 Grade A Tube or fabricated from weldable grade, hot-rolled, commercial quality steel, meeting the requirements of ASTM A 607, with a minimum yield strength of 55,000 psi (380 MPa) after fabrication. The round shaft shall be fabricated in one piece from not less than # 11 manufacturer's standard gauge steel and be continuously tapered at 0.14 or 0.10 in. per ft. (3.04 mm/m). Two piece shafts, that assemble by telescoping the upper section over the lower section with a firm tapered fit, may be used for 40, 45, 50, 55 and 60 ft. (11.7 or 8.33 mm per meter) mounting heights. Each pole shaft shall include a J-hook wire support welded inside near the top, a handhole with cover as noted on the plans (except for transformer bases), and a ground connector near the bottom. An opening shall be provided near the top of the shaft to provide a cable entrance from the shaft into the luminaire support arm.

**662.2.13.1.3-Luminaire Support Arm Types I and II:** Luminaire support arms for Lighting Poles Types I and II shall be of constant diameter and fabricated from 2 in. pipe, having a wall thickness equal to Schedule 40 pipe and meeting the requirements of ASTM A 501, or from 2-<sup>3</sup>/<sub>8</sub> in. steel tubular members with a nominal wall thickness equal to Schedule 40 pipe and having a minimum yield strength equal to ASTM A36. For arm spreads 12 ft. (3.6 m) and less, the fabrication of the lower member may be of 1½ in pipe, having a wall thickness equal to Schedule 40 pipe. For arm spreads over 18 ft. (5.5 m), the fabrication may be of 2½ in. pipe, having a wall thickness equal to Schedule 40 pipe, or a combination of 2½ in. and 2 in. meeting the above requirements. The arm shall be attached to the pole so that it can transfer the full strength of the arm to the pole shaft.

The truss type arm (Type I) shall consist of an upper and lower member joined near the luminaire end of the arm and securely joined with vertical

strut(s). The upper member shall be continuous and the wiring member. The vertical strut(s) shall be either oval, circular, rectangular or square in cross section and shall be made of steel meeting the physical requirements of ASTM A 36.

A 2 in. (50 mm) slip fitting arrangement shall be provided at the tip of all arms.

**662.2.13.1.4-Luminaire Support Arm Type III:** Luminaire support arms for Lighting Pole Type III shall be an ASTM A 595 Grade A Tube or fabricated from weldable grade, hot rolled, commercial quality steel, meeting the requirements of ASTM A 607, with a minimum yield strength of 55,000 psi (380 MPa) after fabrication. The arm shall be cylindrical in cross section and uniformly tapered from butt to tip at 0.14 or 0.10 in. per foot (11.67 or 8.33 mm per meter). The arm shall be fabricated in one piece from not less than # 11 (3.04 mm) manufacturer's standard gage steel. The arm shall be attached to the pole so that it can transfer the full strength of the arm to the pole shaft.

Two-piece arms may be used for spreads greater than 34 feet (10.4 m). The outside luminaire support arm shall be a round tapered tubular member fabricated from material with a minimum yield strength of 36,000 psi (10.4 m) after fabrication. Two-piece arms shall assemble by a telescoping joint. The telescoping length of the joint shall not be less than 1½ times the diameter of the arm at the joint. The telescoping field joint shall not be welded but shall be keyed with a through bolt.

A 2 in. (50 mm) slip fitting arrangement shall be provided at the tip of all arms.

**662.2.13.1.5-Bases:** Anchor, support and approved breakaway bases shall be constructed of sufficient size and strength to fully develop the bending moment of the shaft. Each base shall be provided with four holes (slip base may have three) of sufficient size to accommodate the proper size anchor bolts to resist at yield stress, the bending moment of the shaft at its yield stress. All bases, except the transformer type, shall have the handhole centered approximately 18 in. (450 mm) above the bottom of the shaft located downstream of oncoming traffic.

Anchor bases shall be one-piece fabricated from material meeting ASTM A 27 Grade 65-35 or ASTM A 36 of sufficient cross section to fully develop the ultimate strength of the pole. Galvanizing shall be in accordance with ASTM A 123.

Breakaway bases (e.g. aluminum transformer, cast aluminum, fluted aluminum breakaway couplings, slip, etc.), if required, shall meet the dimensions and requirements as required by the Plans. All breakaway bases shall be certified for conformance to the AASHTO breakaway performance criteria.

The aluminum transformer bases shall be nominally 20 in. (500 mm) high with an access door secured in place by stainless steel locking screws. All

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bearing plates shall be hot-dipped galvanized in accordance with ASTM A 123. Washers shall be hot-dipped galvanized in accordance with ASTM A 153. A tapped hole shall be provided for grounding. **When aluminum transformer bases are used with steel anchor base poles, both the bottom of the steel anchor base and the top of the aluminum transformer base shall be coated or painted with a heavy film of zinc-rich paint.**

**662.2.13.1.6-Anchor Bolts:** Anchor bolts shall be of sufficient size and strength to fully develop the bending moment of the shaft. **Anchor bolts (unless otherwise directed on the Plans) shall be fabricated from ASTM A1444 Gr. 55.** Each bolt shall have the thread end galvanized for a length sufficient to extend down through the grout and into the concrete foundation. Each bolt shall be provided with a regular hex nut or heavy hex nut (anchor bases to have two hex nuts) that shall be hot dipped galvanized. Hex nuts shall be regular meeting ASTM A 563 Grade A for ¼ in.- 1½ in. (6 through 38 mm) sizes and shall be heavy hex for sizes over 1½ in. to 4 inches (38 to 102 mm).

**662.2.13.1.7-Galvanizing:** The pole shaft, luminaire support arm, pole top, handhole cover, anchor base and slip base shall be galvanized in accordance with ASTM A 123. Galvanized coatings damaged for any reason shall be repaired by the application of a zinc rich paint conforming with [711.21](#) of the Specifications. The places to be painted shall be thoroughly cleaned before the paint is applied.

**662.2.13.1.8-Marking:** Each pole shall be identified by control station number (as applicable), circuit number (as applicable), wattage and pole number with adhesive labels applied 6 feet (1.8 m) above the grade line normal to the roadway. Adhesive labels shall be designed to be exposed to the weather. Legend shall be 3 inches (75 mm) black on white.

**662.2.13.1.9-Drawings for Approval Purposes:** Two prints of shop drawings indicating the proposed dimensions and material specifications for each of the components involved shall be submitted by the Contractor for approval purposes within three weeks after the award of Contract. These drawings will be reviewed by the Division at the earliest possible date and one print will be returned marked "Approved" or "Returned for Revisions as Noted." Eight sets of drawings shall then be submitted for final approval. Appropriate action shall be taken by the Contractor after final approval to insure that the earliest possible erection of these items can be achieved.

Resubmission of drawings to obtain final approval by the Division shall not be considered as being just cause for delay in the completion of any contract.

**662.2.13.1.10-Mill Test Reports and Certification:** Mill test reports or certifications of conformance to specifications for materials and design will be required for all materials incorporated into the work. The following shall be supplied by the Contractor prior to acceptance of the structures:

- i. Mill Test Reports (M.T.R.) for MAJOR structural items only, as noted in the following chart, shall include both physical and chemical descriptions of the material as supplied to the fabricator. When physical properties are altered during fabrication, the M.T.R. covering chemical composition will be supplemented by certified test reports indicating the physical properties of this material after fabrication.
- ii. Certification of Conformance to the Specifications for all remaining material not covered by M.T.R. as noted in the following chart.
- iii. Certification that all welding was performed by operators qualified as follows: steel welders to AWS and aluminum welders to ASME.
- iv. Certification of Conformance to the Specifications for the Design of all components not completely dimensioned and detailed on the Standard Drawing.

TABLE 662.2.13.1.10		
COMPONENT MATERIALS	M.T.R.	CERTIFICATIONS
Tubes for arms and poles	X	
Base castings	X	
Anchor bolts	X	
Pole tops, misc. fittings and hardware		X
Fabricated or cast-type arm connections	X	
Galvanizing		X
Welding Rod	X	

#### 662.2.13.2-Lighting Pole Type IV-Wood:

**662.2.13.2.1-General Description:** Each Type IV Wood Pole shall consist of an upright shaft fitted with necessary hardware to make the installation complete as detailed on the contract Plans.

All wood poles shall meet the requirements of Section [710.8](#).

**662.2.13.2.2-Luminaire Support Arms:** Luminaire support arms for Type IV Lighting Poles shall be of constant diameter and fabricated from 2 in. pipe, having a wall thickness equal to Schedule 40 pipe and meeting the

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requirements of ASTM A 501, or from 2-3/8 inch OD steel tubular members with a nominal wall thickness equal to Schedule 40 pipe and having a minimum yield strength equal to ASTM A 36. For arm spreads over 18 ft. (5.5 m), the fabrication may be of 2 1/2 in. pipe having a wall thickness equal to Schedule 40 pipe, or a combination of 2 1/2 in. and 2 in., meeting the above requirements.

The method of attachment to the pole shall be that as suggested by the support arm manufacturer and approved by the Engineer.

A 2-in. (50 mm) slip fitting arrangement shall be provided at the tip of all arms.

### **662.2.13.3-Lighting Pole Type V and VII-Aluminum :**

**662.2.13.3.1-General Description:** Each Lighting Pole Type V "Luminaire Support Arm Mounted" shall consist of a pole shaft, removable pole top, luminaire support arm, base, support base (if required), anchor bolts, removable anchor bolt covers and any other accessories or hardware as required to make a complete installation as called for on the Plans or as directed by the Engineer. Each Lighting Pole Type VII "Luminaire Post Top Mounted" shall consist of a pole shaft, base, anchor bolts, removable anchor bolt covers and any other accessories or hardware as required to make a complete installation as called for on the Plans or as directed by the Engineer. Spreads and mounting heights shall be as detailed on the Plans; tolerance for mounting heights shall be plus or minus 6 inches (150 mm). All wiring shall be concealed within the pole shaft and luminaire support arm.

Lighting Poles Type V and VII shall be certified to be equal or exceed the requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals". Type V shall be based on at least 80 mph (129 km/hr) wind loads, a luminaire weight of 70 lb. (31.7 kg) and a luminaire projected area of 3.0 sq. feet (0.279 sq. m). Type VII shall be based on 80 mph (129 km/hr), ignore the weight and 2.5 sq. feet (0.232 sq. m).

The maximum allowable pole deflection from vertical at the top of the pole, due to the weight of the arm and luminaire, shall be two percent of the total shaft length. The pole deflection from vertical is defined as the horizontal distance between the pole top centerline after the arm and luminaire combination is installed on the previously plumb pole, and measurement to be made without additional shaft adjustment. The fabricator must certify to the above and maintain results of computations or tests to document compliance for each type of lighting pole supplied.

**662.2.13.3.2-Pole Shaft:** The pole shaft shall be one-piece, cylindrical, tapered seamless (or one continuous longitudinal weld) tubing which shall have mechanical properties not less than that listed for ASTM B221, B429, B241, or B209 after fabrication. Two-piece shafts, that assemble by telescoping the upper section over the lower section with a firm tapered fit, maybe used for 40, 45 and 50 ft. (12.13, 13.72 and 15.24 meter) mounting heights. Each pole shaft shall have a J-hook wire support inside near the top, a handhole with cover as

noted on the Plans (except for transformer bases) and a ground connector near the bottom. Minimum wall thickness (unless otherwise approved by the Engineer) shall be 0.188 in. (4.775 mm) for Type V poles and 0.125 in. (3.175 mm) for Type VII poles. The top of shaft OD for "Luminaire Post Top Mounted" shall be 3 inches (75 mm) unless otherwise approved by the Engineer.

**662.2.13.3.3-Luminaire Support Arm:** The luminaire support arm shall be aluminum pipe or tapered aluminum tubing made from ASTM B221, B429, B241, or B209 which shall have mechanical properties not less than that listed for ASTM B221, B429, B241, or B209 after fabrication. A 2-in.(50 mm) slip fitting arrangement shall be provided at the tip of all arms.

**662.2.13.3.4-Bases:** Anchor, support and approved breakaway bases shall be constructed of sufficient size and strength to fully develop the bending moment of the shaft. Each base shall be provided with four holes (three if approved by the Engineer) of sufficient size to accommodate the proper size anchor bolts to resist at yield stress, the bending moment of the shaft at its yield stress. All bases, except the transformer type, shall have a handhole centered approximately 18 in. (450 mm) above the bottom of the shaft located downstream of oncoming traffic.

Anchor bases shall be made from Alloy ASTM B108 as detailed on the Plans or as directed by the Engineer. Support bases shall be fabricated from steel conforming to ASTM A 36, with galvanizing in accordance with ASTM A 123. Aluminum transformer bases shall meet the requirements as identified in the fourth paragraph of 662.2.13.1.5.

Breakaway bases (e.g. aluminum transformer, cast aluminum, fluted aluminum breakaway couplings, slip etc.), if required, shall meet the dimensions and requirements as required by the Plans. All breakaway bases shall be certified for conformance to the latest AASHTO breakaway performance criteria.

**662.2.13.3.5-Anchor Bolts:** Anchor bolts shall be of sufficient size and strength to fully develop the bending moment of the shaft. **Anchor bolts (unless otherwise directed on the Plans) shall be fabricated from ASTM A1554 Gr. 55.** Each bolt shall have the threaded end galvanized for a length sufficient to extend down through the grout and into the concrete foundation. Each bolt shall be provided with a regular hex nut or heavy hex nut (anchor bases to have two hex nuts) that shall be hot dipped galvanized. Hex nuts shall be regular meeting ASTM A 563 Grade A for ¼ in. (6 mm) to 1½ in. (38 mm) sizes and shall be heavy hex for sizes over 1 ½ in. to 4 inches (38 to 102 mm).

**662.2.13.3.6-Marking:** Each pole shall be identified as required in 662.2.13.1.8.

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**662.2.13.3.7-Drawings for Approval Purposes:** Shop Drawings shall be submitted, approved and applied as required in 662.2.13.1.9.

**662.2.13.3.8-Mill Test Reports and Certification:** Mill test reports or certifications of conformance to specifications for materials and design shall be supplied as required in 662.2.13.1.10.

### 662.2.13.4-Lighting Pole Type X-Steel High Mast:

**662.2.13.4.1-General Description:** Each Lighting Pole Type X shall consist of pole shaft, anchor base, anchor bolts and nuts, lowering devices and any other accessories or hardware as required to make a complete installation as called for on the Plans or as directed by the Engineer. Mounting heights, number and type of luminaires shall be as detailed on the Plans. Tolerance for mounting heights shall be plus or minus 12 inches (300 mm). Any manufacturer's warranties, expressed or implied, shall become the property of the Division.

A complete service manual including instruction on installation, operation and maintenance shall be furnished for each lowering device, winch assembly and power drive system furnished on each project.

Lighting Poles Type X shall be certified to be equal or exceed the requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals," based on the Final Deflected Pole Position Method and the following:

Wind Velocity	= 90 mph. (144.8 km/hr)
Number of Luminaires	= 8
Weight of Luminaires	= 70 lbs. Each (560 lbs. total) (31.8 kg each {254 kg total})
Area of Luminaires	= 2.8 sq. ft. Each (22.4 sq. ft. total) (0.26 sq. meter each (2.081 sq. meters total))
Weight of Mounting Head	= 370 lb. (167.8 kg)
Area of Mounting Head	= 3.5 sq. ft. (0.325 sq. meter)

**662.2.13.4.2-Pole Shaft:** The pole shaft shall be made from one to six continuously tapered circular or twelve sided sections which shall either telescope with each other or be shop butt welded by electric arc welding. Steel used in fabricating the shaft shall be either galvanized steel (hot-dipped according to ASTM A 123) or weathering steel with a minimum yield strength of 55,000 psi (380 MPa) after fabrication and shall have one or two

longitudinal welds. Materials shall be galvanized steel unless otherwise indicated on the Plans as weathering steel. All poles on any one project shall be of the same type construction for pieces and sections. Straightness tolerance shall be ½ inch in 20 feet (2.08 mm per meter). The inside surface of the shaft shall be relatively smooth to provide a cable raceway. Projections on the inside of the pole (such as backup rings) shall not exceed ⅜ in. (9.5 mm) projection in the area between the handhole and the top flange.

Minor sections of galvanized coatings (of pole shaft, pole support assembly and circular luminaire ring assembly) damaged for any reason shall be repaired by the application of a zinc rich paint conforming with 711.21 of the Standard Specifications. The places to be painted shall be thoroughly cleaned before the paint is applied.

The lap joint produced by telescoping shall have a minimum length of one and one-half diameters of the shaft at the joint measured at the minimum diameter of the inner telescoping section. No transverse welding shall be permitted to secure the overlapping telescoping joints. Overlap areas on weathering steel poles shall be shop painted in accordance with 688. The outside of the lower pole shall be coated so a minimum of 1 in. (25 mm) below the bottom edge of the upper pole is covered (after erection). The inside of the upper pole shall be coated so a minimum of 6 inches (150 mm) above the top edge of the lower pole is covered (after erection). In addition the intersection of each overlap joint on the outside shall be sealed with a commercial silicone building sealant such as Dow Corning 795. The numbering shall be applied in such fashion that the marks shall be unobtrusive after assembly.

In the bottom section of the shaft shall be an access door with stainless steel hinged door, neoprene door gasket and hasp (welded inside to the reinforcing frame, sleeve or plate) with an all weather padlock. The door shall be sufficient size to allow the internal machinery (winch and gear box) to be disconnected from its mountings and removed through the door. An additional handhole may be provided for wiring access. All handholes or openings in the shaft shall be properly designed and fabricated to avoid stress risers by use of an internal reinforcing sleeve or a reinforcing frame with full penetration welds or other approved method.

Each pole shall be identified by control station number (as applicable), circuit number (as applicable), wattage and pole number with adhesive labels applied 8 feet (2.4 m) above the base plate normal to the nearest roadway. Adhesive labels shall be designed to be exposed to the weather. This legend shall be 5 inches (125 mm) black on white.

**662.2.13.4.3-Anchor Base:** The anchor base (cast or rolled steel) shall be constructed of ASTM A 36 minimum for galvanized steel or ASTM A 588 for weathering steel and shall be of sufficient size and strength to fully develop the bending moment of the shaft. It shall be welded to the shaft by a full penetration weld. The weld must be made with a backup ring, or other approved procedure, or be welded from both sides.



**662.2.13.4.4-Anchor Bolts:** Anchor bolts shall be of sufficient size and strength to fully develop the bending moment of the shaft. Anchor bolts shall be fabricated from ASTM A1554 Gr.55. Each bolt shall have the threaded end galvanized for a length sufficient to extend down through the grout and into the concrete foundation. Each bolt shall be provided with two heavy hex nuts and two heavy washers. Both nuts and washers shall be hotdipped galvanized. Detailed properties, dimensions, bolt circles and appropriate backup calculations for anchor bolts for each type pole supplied shall be submitted to and approved by the Division before fabrication.

**662.2.13.4.5-Miscellaneous Hardware:** Miscellaneous other hardware not covered by other specifications shall as a minimum comply with the following:

Galvanized steel structures:

Miscellaneous plates, bars and structural shapes shall be ASTM A 36. Pipe shall be ASTM A 501.

Weathering steel Structures:

Miscellaneous plates, bars and structural shapes shall be ASTM A 588. Pipe shall be Yolo high strength, low alloy steel or approved equal.

**662.2.13.4.6-Welding:** All welding shall conform to AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", Section 1.4.2(A) through (D). Welding must be certified to performance by operators qualified as follows: Steel welders to AWS and aluminum welders to ASME. Longitudinal joints in the tapered sections of the pole shaft shall be made only by automatic electric arc welding. Transverse butt-welds may be used, but only under closely controlled shop conditions. Winch mount plate and emergency stop ring welds shall be fillet welds.

All welds in the shaft shall be tested and certified by close visual inspection or approved alternate methods (such as ultrasonic or magnetic particle). One hundred percent of the full penetration sections of longitudinal seam welds shall be radiographically inspected and a random ten percent of the partial penetration section of the longitudinal seam welds shall be inspected by the magnetic particle method.

**662.2.13.4.7-Lowering Devices:**

**662.2.13.4.7.1-General Description:** The integral luminaire lowering mechanism or devices shall be compatible with the pole design and shall consist of a head frame assembly, a luminaire ring assembly and a hoisting assembly. The system shall permit luminaire maintenance at ground level, provide for disconnection of the electrical service at the pole base, provide a convenient means of energizing the lighting assembly when it is at ground level, support eight 70 lb. (31.75 kg) luminaires in a symmetrical arrangement and include

power cables and all miscellaneous electrical equipment in the pole necessary to provide a complete and workable device. All bolts and machine screws shall be secured in a manner that will preclude their becoming loosened by vibration. Star washers, jam nuts, self-locking nuts, locktite, etc., may be used to secure nuts and machine screws. Sheave pins shall be secured by means of washers and cotter keys or pins, not welded.

**662.2.13.4.7.2-Head Frame Assembly:** The head frame structure shall be galvanized steel, attached to the pole by a steel slipfitter and secured by the appropriate stainless steel setscrews. It shall consist of all necessary pulleys and rollers to guide the hoisting cables and electrical cable. The head frame shall support six, 6 in. (142.4 mm) diameter steel hoist cable sheaves or six, 5 in. (127.0 mm) diameter cast aluminum hoist cable sheaves with oil-impregnated, sintered bronze bushing with stainless steel shafts. The three hoisting cables shall be stainless steel 7 x 19 aircraft cord of 3/16 in. (4.7625 mm) diameter. The minimum tread diameter for the hoisting cable sheaves shall be 20 times the cable diameter for galvanized cable and 25 times the cable diameter for stainless steel cable. The hoisting cable sheave groove cross-section shall be semicircular with a radius of one-half the cable diameter plus 1/64 inch (396 µm).

The power cable shall not be bent at a radius less than five times the cable diameter and the groove cross-section shall prevent the cable from rolling out of the groove if the cable is twisting. All power cable sheaves and rollers shall be suspended on stainless steel shafts fitted with self-lubricating bushings or be fabricated of self-lubricating material.

All head frame sheaves will have keepers to keep cables engaged during operation.

The head frame assembly shall be protected from the weather by an aluminum cover.

Positive latching devices shall be incorporated into the luminaire ring assembly. These devices shall be designed to prevent any movement of the luminaire ring assembly when it is latched to the top of the pole and tension is removed from the luminaire ring support cables. Latching shall be accomplished by the alternate raising and lowering of the luminaire ring assembly by the winch and hoisting assembly and there shall be no moving latch parts or springs attached to the head frame assembly. Reflectors or flags shall be provided to indicate when the luminaire ring assembly is completely and securely latched to the head frame assembly. All moving parts of the latching mechanism shall be attached to the luminaire ring assembly and serviceable from the ground.

**662.2.13.4.7.3-Luminaire Ring Assembly:** The luminaire ring shall be fabricated of 6 in. (150 mm) steel channel, hot dipped galvanized with the appropriate number of 2 in. (50 mm) nominal galvanized steel pipe mounting arms. The luminaire ring shall be wired with Type S.O. power cable or

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equivalent and Type ST distribution cable with insulation suitable for at least 105 C.

All electrical cords shall be attached to the weathertight wiring chamber through weathertight cable connections. A prewired 600 volt terminal block and a secondary lightning arrester shall be provided in the weathertight chamber. A weathertight twistlock power inlet shall be provided on the chamber to allow testing of the luminaires while in the lower position.

Roller-contact, spring-loaded centering arms shall be provided to stabilize and center the luminaire ring during raising or lowering operations and to eliminate shock to the lamps from impact of the luminaire ring with the pole.

The rollers for the centering arms shall be of a water-resistant, non-marking material with oil-impregnated sintered bronze bushings. All axle shafts for arms and rollers shall be stainless steel.

**662.2.13.4.7.4-Housing Assembly (Winch Assembly):** The winch shall have an ultimate strength of five times the lifted load with the number of layers of cable with which it will be used. The winch shall have a 30 to 1 worm gear reduction ratio and include an integral drag brake on the worm shaft to prevent free spooling of the winch. The winch shall be designed for at least intermittent power operation, but also have hand crank capability.

The winch shall be prewound with galvanized steel ¼ inch (6.35 mm), 7 x 19 aircraft cord of sufficient length to maintain at least four complete wraps on the drum after the device has been lowered to its lowest position. The drum shall be supported at both ends and keepers shall be provided to ensure that uncoiled cable will rewrap onto the drum.

A portable power unit is required (one per project). Its motor shall be the heavy-duty reversing type with a stalling torque at least twice that required to operate the device. The motor shall drive the winch through the torque limiter coupling to limit the lifting force. The hoisting rate shall be between 12 and 25 feet (3.6 and 7.5 m) per minute. The motor shall be controlled by a reversing switch connected by a 20 foot (6.1 m) remote cord. The portable power unit shall be provided with a portable enclosed and encapsulated transformer to stepdown the parent voltage to 120 volts to operate the power unit. All electrical connections from the transformer to the power cord and from the transformer to the power unit shall be twistlock caps and plugs.

### **662.2.13.4.8-Wire Rope:**

**662.13.4.8.1-Materials** for the stainless steel cables shall conform to the Chemistry of ASTM A492 type 302 or 304.

The wire used in steel cable shall be cylindrical and smooth and of uniform high quality. The finished cable shall be uniform in construction and securely laid, free from kinks, loose wires, loose strands, splits, cold shuts or other defects. A suitable type of friction-preventive compound having noncorrosive properties shall be impregnated into the wire rope. The individual wires and strands composing the wire rope shall be shaped into the exact helical position they will have in the finished wire rope, so that if the wire rope is cut or severed

there is no tendency for the measured diameter of the wire rope at the unseized cut ends to increase by more than the amount specified in Table 662.2.13.4.8.

<b>TABLE 662.2.13.4.8 {ENGLISH}</b> <b>CONSTRUCTION, PHYSICAL PROPERTIES OF STAINLESS</b> <b>STEEL WIRE ROPE</b>				
<b>Nominal Diameter of Wire Rope (Inches)</b>	<b>Tolerance on Diameter (Plus Only) (Inches)</b>	<b>Allowable Increase of Diameter (Inches)</b>	<b>Nominal Break Strength Stainless Steel (Pounds)</b>	<b>Approximate Weight per 100 ft. (Pounds)</b>
5/32	.016	.017	2,400	4.50
3/16	.018	.019	3,700	6.50
7/32	.018	.020	5,000	8.60
1/4	.018	.021	6,400	11.00
5/16	.022	.024	9,000	17.30
3/8	.026	.027	12,000	24.30

<b>TABLE 662.2.13.4.8 {METRIC}</b> <b>CONSTRUCTION, PHYSICAL PROPERTIES OF STAINLESS</b> <b>STEEL WIRE ROPE</b>				
<b>Nominal Diameter of Wire Rope (millimeters)</b>	<b>Tolerance on Diameter (Plus Only) (millimeters)</b>	<b>Allowable Increase of Diameter (millimeters)</b>	<b>Nominal Break Strength Stainless Steel (kilograms)</b>	<b>Approximate Weight per 30.48 meters (kilograms)</b>
3.96	0.4064	0.4318	1090	0.16
4.762	0.4572	0.4826	1680	0.90
5.556	0.4572	0.5080	2270	1.19
6.350	0.4572	0.5334	2900	1.52
7.935	0.5588	0.6096	4080	2.39
9.525	0.6604	0.6858	5445	3.36

Flexible steel wire rope covered by this specification shall be of 7 x 19 construction. The type of construction for the respective diameters, the dimensional tolerances and the physical properties shall be as specified in Table 662.2.13.4.8. Wire rope shall be 7x19 aircraft cable.

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**662.2.13.4.8.2-Quality conformance testing** shall consist of all the inspections such as workmanship and physical appearance previously specified. The sample wire rope shall pass the breaking strength test and stretch tests as specified below.

- i. Sampling-When conducting the tests, one sample shall be taken after any discard has been removed from the head or starting end of the first manufacturing reel for each lot of wire rope.
- ii. Lot-A lot shall consist of not more than 20,000 ft. (6 100 meters) of wire rope of the same construction and diameter produced continuously by one machine or by one series of progressive processing machines.

**662.2.13.4.8.3-Breaking Strength:** The wire rope specimen shall be selected from the sample from each lot. The specimen shall be no less than 24 inches (600 mm) in length, and where necessary, swaged terminals conforming to MIL-T-781 (do not use ball end fitting) and accompanying hardware may be used to facilitate installation of the specimen in the jaws of the testing machine. The distance between the jaws of the testing machine with the sample shall be no less than 10 inches (250 mm). The breaking strength shall be determined by use of a tensile testing machine in accordance with applicable requirements of ASTM E 8. The breaking strength shall conform to the requirements of Table 662.2.13.4.8 for qualification.

**662.2.13.4.8.4-Stretch Test:** One specimen from each sample of wire rope selected as specified in 662.2.13.4.8.2 shall be tested to determine the percent stretch. The total length of the wire rope specimen to be tested shall not be less than 24 inches (600 mm). Where necessary, swaged terminals and accompanying hardware may be used to facilitate installation of the specimen in the jaws of the test machine. The amount of stretch shall be determined on a tension testing machine in accordance with ASTM E 8. The specimen shall be loaded to one percent nominal breaking strength shown in Table 662.2.13.4.8 to straighten the wire rope. While the specimen is under tension, an adequate gauge length shall be marked off the wire rope between the jaws of the testing machine. The specimen shall then be loaded to 60 percent of minimum breaking strength and measured to elongation under load. From this data the stretch shall not exceed 1.5 percent.

**662.2.13.4.8.5-Certification:** Upon request, the wire rope manufacturer shall furnish a certified test report showing that the wire rope manufacturer's product satisfactorily conforms to this Specification. The test report shall include, as a minimum, actual results of the tests specified.

**662.2.13.4.9-Drawings for Approval Purposes:** Two prints of shop drawings indicating the proposed dimensions and material specifications for the poles and lowering devices shall be submitted by the Contractor for

approval purposes within three weeks after the award of the Contract. These drawings will be reviewed by the Division at the earliest possible date and one print will be returned marked "Approved" or "Returned for Revisions as Noted." Eight sets of drawings shall then be submitted for final approval. Appropriate action shall be taken by the Contractor after final approval to insure that the earliest possible erection of these items can be achieved. Resubmission of drawings to obtain final approval by the Division shall not be considered as being just cause for delay in the completion of any contract.

**662.2.13.4.10-Mill Test Reports and Certification:** Mill test reports or certificates of conformance to specifications for materials and design will be required for all materials incorporated into the work. The following shall be supplied by the Contractor prior to acceptance of the structures:

- i. Mill Test Reports (M.T.R.) for MAJOR structural items only, as noted in the following chart, shall include both physical and chemical descriptions of the material as supplied to the fabricator. When physical properties are altered during fabrication, the M.T.R. covering chemical composition will be supplemented by certified test reports indicating the physical properties of this material after fabrication.
- ii. Certification of Conformance to the Specifications for all remaining material not covered by M.T.R. as noted in the following chart.
- iii. Certification of Conformance to the Specifications for the design of all components not completely dimensioned and detailed on the Standard drawing.

<b>TABLE 662.2.13.4.10</b>		
<b>COMPONENT MATERIALS</b>	<b>M.T.R.</b>	<b>CERTIFICATIONS</b>
Tubes for poles	X	
Base Castings	X	
Anchor bolts	X	
Pole tops, lowering devices, cable, misc., fittings, and hardware		X
Galvanizing		X
Welding Rod	X	

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**662.2.14-Navigation Lighting System:** The Contractor shall furnish and install a navigation lighting system as indicated on the Plans. The navigation lighting system shall consist of control center, enclosure, power service, conduit, cable, junction boxes, navigation light unit, photoelectric unit, electrical work, electrical tests and all other incidentals for a complete and operable system as called for on the Plans.

**662.2.14.1-General:** The installation, equipment, materials and workmanship, except as specifically modified, shall be in accordance with applicable provisions of the following publications, codes and regulations in effect on the date of the invitation for bids:

National Electrical Code  
American National Standards Institute  
National Electrical Manufacturer's Association  
Insulated Power Cable Engineers Association  
U.S. Coast Guard Publication, "A Guide to Bridge Lighting"  
Enclosure 6 to COMDTINST M16590.5  
Federal Aviation Administration "Obstruction Marking and Lighting"  
AC70/7460-IF  
Regulations of local power company

In the event of conflict in any requirements of the above standards, the Engineer will determine which authority is applicable.

Two prints of shop drawings indicating the proposed dimensions and material specifications for the control center, enclosure, transformer, if required, and navigation light unit shall be submitted for approval purposes within three weeks after the award of the Contract. These drawings will be reviewed by the Division at the earliest possible date and one print will be returned marked "Approved" or "Returned for Revisions as Noted". Eight sets of drawings shall then be submitted for final approval. Resubmission of drawings to obtain final approval by the Division shall not be considered as being just cause for delay in completion of any contract.

After the installation is completed, the Contractor shall conduct a continuous 24-hour operating test for approval. In addition, final acceptance of any installation will not occur until 30 days of operation termed satisfactory by the Engineer.

### 662.2.14.2-Navigation Lighting (Surface):

**662.2.14.2.1-General:** Navigation lights shall be securely mounted to the bridge structure or substructure and shall show through a horizontal arc of 360° for green lights and show through a horizontal arc of 180° for red lights as specified or detailed in the Plans. They shall be pivot-swivel mounted or pedestal mounted as specified. The pivot mounted lights shall have a locking mechanism and service-retrieving chain made of corrosion-resistant non-plastic

material.

The navigation lights shall have one or two lenses with one or two lamps as specified but unless otherwise noted, are to have one lens with one lamp.

The lamps shall be 100-W, 120-V, rated at 5-years. The lenses shall be fresnel glass eight in. (203 mm) (177 mm minimum I. D.). The signal housing shall be made of aluminum, silicon bronze or cast bronze and shall be watertight with weather-proof gaskets.

The hangar stem shall be 1½ in. (40 mm) minimum galvanized steel pipe or 1½ in. (40 mm) minimum stainless steel pipe. The mounting bracket and hangar housing shall be cast silicon bronze with stainless steel pivot and shall be watertight.

The cable shall be #16 S. O. minimum and all connections shall be watertight. Any other structural connections shall be watertight and of good quality non-corrosive construction.

The pedestal mounted light shall meet all of the aforementioned light, lamp, lense, signal housing, cable and structural connection requirements. The pedestal mounted stem itself shall be similar to and meet the requirement of the pivot mounted hangar stem requirements.

Navigation lights shall be provided with supports constructed of steel meeting ASTM A 36. Each fixture shall be individually protected by "in the line" fuses as manufactured by ESNA Corporation, Bussman Manufacturing Division of McGraw-Edison Company, HOMAC, or approved equal.

The photoelectric control for navigation lights shall provide automatic switching of circuits. The unit shall be oriented as nearly as possible to face the northern sky. Initial settings shall be 35 footcandles for "turn on" and 58 footcandles for "turn off". The unit shall be housed in a weatherproof enclosure of the twistlock type. The unit shall be "fail safe", i.e., failure of the electronic circuit will "turn on" the navigation lights. The unit shall be suitable for operation in three-wire, 120/240 Volt, 60 Hz. circuits.

**662.2.14.2.2-Power Service:** Power shall be received at a location noted on the Plans or as directed by the Engineer. Power will be 120/240 Volt single phase, 60 Hz., three-wire from the Power Company. Materials to be furnished and installed by the Contractor will be as designated on the Plans or as directed by the Engineer.

**662.2.14.2.3-Cable:** Cable shall be single conductor, stranded copper, 600 Volt, Type THW. Cable for the final connection to swivel mounted navigation lights shall be three or four conductor stranded copper, 600 V, Type S. O. Cable splicing will be permitted in junction boxes only.

## CONSTRUCTION METHODS

### 662.3-GENERAL:

The Plans show, in general, the location of the roadway lighting systems



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and other incidental work to be performed. They are diagrammatic only, but shall be followed as closely as actual site conditions will permit.

Any alternate design or significant departure from the Plans proposed by the Contractor must be prepared by the Contractor in written or plan form, or both, and presented in writing to the Division for approval. The Division will not approve substitution of material or design detail changes which constitute a reduction in quality, workmanship, or strength of the materials involved.

#### **662.4-CONCRETE:**

Concrete shall be mixed and placed in accordance with Section 601 of the Standard Specifications.

#### **662.5-CONDUIT:**

Conduits shall be of the size and type noted on the Plans. Conduit shall be installed at a minimum depth of 18 in. (450 mm) and at a distance of at least 6 inches (150 mm) from any utility line. Conduit runs shall be continuous in size from terminal point to terminal point. No reducing coupling will be permitted. All unused conduits shall be threaded and capped. Unused conduits terminating underground shall also be marked with a concrete marker.

The threads on all steel pipe conduit shall be painted with rust preventative paint meeting Military Specification MIL-P-21035 before couplings are made. All couplings shall be tightened until the ends of conduits are brought together. Conduits stubs, caps, exposed threads, or damaged galvanized areas shall be painted with rust preventive paint meeting Military Specification MIL-P-21035.

Expansion deflection fittings shall be installed in metallic conduit runs in bridge structures and in retaining walls at all expansion joints and all stringer (stress) relief joints and all other locations as specified on the Plans. These fittings shall be bonded with approved flexible tinned copper bonding jumpers.

Conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without permission of the Engineer. In the event obstructions are encountered, upon approval of the Engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept 2 feet (600 mm) clear of the edge of any type of pavement wherever possible. Water jetting will not be permitted.

PVC conduit shall be made water tight by joining with solvent as per the manufacturer's recommendations. Ends terminating in junction boxes shall be terminated with end bells. Ends joining to metal conduit elbows at foundations shall be connected through expansion couplings and adapters.

Approximate lengths of conduit are shown on the Plans. It is the responsibility of the Contractor to determine exact lengths of conduit runs in the field.

A number 12 AWG (minimum) galvanized pull wire shall be installed in all conduits which are to receive future conductors. At least 2 feet (600 mm) of pull wire shall be doubled back into the conduit at each termination.

**662.6-BACKFILL:**

All excavations shall be backfilled with suitable random material in horizontal layers not to exceed 4 inches (100 mm) after compaction. Each lift shall be compacted to the satisfaction of the Engineer. Testing is not required.

All surplus material shall be removed from the right-of-way and the backfill finished flush with surrounding natural ground, including replacement of any damaged facilities or appurtenances. The Contractor shall restore all areas disturbed by this excavation or other operations to their original conditions including grading, seeding, mulching and fertilizing as directed by the Engineer.

**662.7-MANHOLES AND JUNCTION BOXES:**

Boxes shall be located as shown on the Plans. Manholes and junction boxes shall be set so that the top of cover will be level with the surface without using an excessive amount of mortar for setting the metal frames.

Fill material for drainage shall be laid 12 in. (300 mm) minimum depth under the entire manhole or junction box. The aggregate used shall be stone or gravel of a grade approved by the Engineer and shall be by visual inspection a uniformly graded mixture of particles from  $\frac{3}{8}$  to  $\frac{3}{4}$  inch (10 to 20 mm) in nominal diameter.

The Contractor may, with the approval of the Engineer and at his own expense, install additional manholes or junction boxes to facilitate the work of installing conduit and pulling cable.

**662.8-LUMINAIRES:**

No luminaire shall be installed until the lamp socket position has been inspected and approved by the Engineer for conformance to the manufacturers recommended position for the specified distribution.

All luminaires shall be properly adjusted to produce the maximum illumination on the roadway surface, without disrupting the intended light distribution pattern.

The connection between the luminaire and connector kits shall be made with # 10 wires.

**662.9-CABLES:**

The Contractor shall provide adequate equipment for installation of cable, and shall pull all wires through conduits in such a manner as not to score, cut, twist or damage the protective covering or insulation. In the pulling of cables into conduits, where the strain on the cables is likely to prove excessive, the Contractor shall use soapstone powder as a lubricant. Where two or more cables are to occupy the same conduit, they shall be drawn in together and kept parallel to each other by the use of a pulling head.

Without exception, cables in manholes, junction boxes and bases shall be provided with an adequate amount of slack for subsequent connects and shall be arranged as ordered by the Engineer. After the cables have been installed

## **662.10**

and pending permanent connection, the end of each section of cable in manholes, junction boxes, bases and panel boxes shall be carefully sealed, using rubber tape, and painted with a sealing type of waterproof compound.

Cables in manholes and junction boxes shall be placed on cable racks while waiting permanent connection. Ends of cable not connected to any device, which are to remain after completion of construction, shall be insulated and sealed in a manner similar to a special splice. Cables in manholes and junction boxes shall be neatly arranged in a workmanlike manner and laced with nylon cable straps.

The Contractor, in connecting sockets, outlets and other similar equipment, shall ground the most accessible bare parts of each piece of equipment. In order ensure that this has been done, each piece of equipment shall be tested after installation, and under the supervision of the Engineer, with a test lamp, one leg of which has been connected to a definite ground, or by other approved means of testing.

All cable in junction boxes and lighting supports shall be tested for circuit connections which shall be in conformity with those indicated on the detail drawings. All cables in junction boxes, manholes and lighting supports/lighting support bases shall be provided with individual non-corrosive metal (minimum 1 ½ in. (40 mm) diameter) tags, die stamped with the control station (as applicable), circuit and phase designation. Similarly designed plastic tags shall be used in control stations. The tags shall be securely attached to the cables with nylon cord of 1/16 in. (2 mm) minimum diameter.

Upon completion of each wiring system, and before any connection is made to operating equipment, it shall be the responsibility of the Contractor to perform, in the presence of the Engineer, the following tests of each circuit to determine where the installations are in acceptable working order:

Tests for continuity

Tests for grounds

Tests for insulation resistance between circuit wires and from circuit wires to ground

Upon completion of the electrical system, with fuses removed and before energizing, the insulation resistance shall be not less than fivemegohms.

## **662.10-CABLE-IN-DUCT:**

At sign bridges where no sign lighting is contemplated under this contract, a sufficient length of cable shall be brought out of the ground or conduit system and extended up to the handhole or junction box of the sign bridge to permit future connections to sign lighting circuits without the need for splicing in additional underground cable.

Underground cable shall be installed at a depth of not less than 30 in. (750 mm) below finished grade or within the protection of galvanized metal conduit under roadways or in structures. Cable to be placed within the protection of conduit in structures may be installed without the polyethylene duct specified,

provided that the duct originating from an underground location is continuous to the first junction box or other terminal connection on the structure. The general location of the cable is shown in the details of the Plans. However, the Contractor shall locate all underground cable in a manner that will preclude damage to cable resulting from subsequent construction operations. The conductor size indicated in the Plans is the minimum size permitted.

Cable placed in continuous conduit raceways shall be terminated with an appropriate splice connection at each junction box provided in the conduit system even though a lighting unit does not exist at that location, unless directed otherwise by the Engineer in the field.

A  $\frac{5}{8}$  in. by 8 ft. (15.88 mm by 2.4 m) copper weld ground rod shall be installed at each ground mounted sign bridge. Installation and connections to units shall be as directed by the Engineer. The grounding conductor shall be connected to the grounding lug in each lighting support and sign bridge column.

The polyethylene ducts, where required, shall be continuous to within 6 inches (150 mm) of a terminal connection.

The Contractor shall exercise care in the installation of the cable-in-duct to insure that the completed duct raceway is smooth and free of sharp bends and that the cables inside the duct are free and are capable of being removed and replaced in the completed cable-in-duct assembly.

Connections and terminations of cable required at existing distribution centers including fuses, hardware and site restoration as required to make the lighting circuits complete and operable, and installation of ground rods to sign bridges shall be considered incidental to this item

#### **662.11-LIGHTING SUPPORTS:**

Lighting supports shall be located in accordance with the details shown on the Plans governing the spacings and set backs to provide continuously aligned lighting support installation, unless otherwise ordered by the Engineer.

**662.11.1-Types I, II, III, IV, V and VII:** Luminaire support arms shall be set normal to the roadway unless otherwise directed by the Plans or the Engineer. Each lighting support (except for twin arm poles and Type VII) shall be raked a horizontal distance from vertical at the top of the pole equal to the taper of the pole in inches per foot (millimeters per meter) times the height of the pole in feet (meters), unless otherwise directed by the Plans or the Engineer. Lighting support wiring shall consist of # 10AWG single conductor, THWN insulated wire for both neutral and phase legs, and shall conform to the requirements for cables outlined in the preceding paragraphs.

When Type V lighting supports are to be erected on bridges, the entire assembly, including support arms and luminaires, shall be fully installed as a complete assembly at one time. When Types V or VII lighting supports are to be in contact with dissimilar materials: e.g., non-galvanized steel or concrete, the contacting parts shall be protected from corrosion by appropriate painting as noted in Section 1.5.4 of AASHTO "Standard Specifications for Structural

### **662.11.2**

Supports for Highway Signs, Luminaires and Traffic Signals".

Aluminum surfaces that are to be in contact with concrete shall be given a heavy coat of alkali-resistant bituminous paint before installation.

The Contractor shall take full responsibility for checking all cross sections to determine final support lengths.

**662.11.2-Type X:** The loading, transporting, unloading and piling of structural materials shall be conducted so that the metal will be kept clean and free from injury in handling. Structural materials shall be stored above the ground upon platforms, skids, blocks or other supports. They shall be kept free from accumulation of dirt, oil, acids, or other foreign matter.

The manufacturer shall supply the Division with complete written instructions for the installation, operation and maintenance of the lighting supports and also complete parts lists for all items included by manufacturer and part number. The Contractor shall install the lighting supports strictly in accordance with the manufacturer's instructions. Extreme care should be exercised during lifting and plumbing. The manufacturer shall supply factory assistance in field assembly and installation when deemed necessary by Division. After the lighting support with all devices has been fully erected, the lowering devices shall be subjected to repetitive cycles of operation as a test.

### **662.12-FOUNDATIONS:**

Footers shall conform to the sizes and shapes shown on the Plans, and shall be poured monolithically. The excavation shall conform to the neat lines of the footer. The top 12 in. (300 mm) and upper portion of the foundation shall be formed and floated and finished smooth on all sides. Castings may be used when deemed necessary by the Engineer to prevent caving of the soil. When casings are used, it is preferable that they be withdrawn as the shaft is filled with concrete. A concrete head of at least 2 feet (600 mm) should be maintained above the bottom of the casing. If any upward movement of the concrete or reinforcement cage occurs at the beginning of the casing pulling operation or at any time during casing pulling, removal should be stopped immediately and the casing left in place.

The conduit bends and anchor bolts shall be accurately set (by template) in the forms and rigidly held in position during concreting operations. No welding shall be permitted on anchor bolts, except at the bottom. Anchor bolts for Type X lighting supports shall be caged into a unit and shall include a steel template at the bottom for presetting. Reinforcement (vertical bars and hooping) shall be completely assembled and placed into position as a unit. The unit must be adequately supported in the excavation to insure centering for the entire length of the shaft.

### **662.13-GROUNDING:**

**662.13.1-General:** The necessary conduit, conductors, bonding jumpers, clamps, connectors, ground rods, etc. for the grounding system shall be

furnished, installed and connected by the Contractor. The grounding system shall be considered as an integral part of the system to which it belongs, e.g. conduit, manholes, junction boxes, luminaires, lighting supports, service and control stations, navigation lighting system, structures, etc. as appropriate.

In general, alternating current circuits, enclosures and frames of electrical apparatus, and conduit systems must be effectively and permanently grounded with a cross section as required by the National Electrical Code and of capacity sufficient to ensure continuity and continued effectiveness of the ground connections for fault current. Ground conductors must be as short and straight as possible, protected from mechanical injury and, where practicable, without splice or joint.

**662.13.2-Codes and Approvals:** All grounding work shall be done in accordance with the latest edition and revisions of the National Electrical Code and the regulations of State and local codes.

All connections in ground network shall be done of a type approved by NEC, Article 250.

**662.13.3-Metal Conduits:** All metal (rigid steel) conduit ends shall be bonded and grounded by means of a # 8 bare copper cable. The grounding shall be accomplished by driving ground rods as detailed on the Standard Drawings or the Plans. Grounding from the conduit to the ground rod in a junction box or manhole shall be accomplished by use of a # 8 bare copper cable. Grounding from the conduit to a lighting support shall be accomplished by use of an insulated (green) copper conductor equal in size to the largest adjoining phase wire except where otherwise called for on the Plans. The connection of the bonding cable to the junction box frames and to the shafts of the lighting supports shall be done by means of a grounding stud. The neutral conductor shall be grounded at the service and control station.

**662.13.4-Lighting Supports on Bridges:** The lighting supports installed on bridge structures shall be grounded by bonding the grounding bushings of the metal conduit terminating to the ground connector in the pole shaft or parapet bracket. The other end of this conduit, which terminates in a junction box, shall be bonded to the junction box frame and to an insulated ground conductor which shall be installed in the same conduit as the lighting circuit conductors. This ground conductor shall be continuous across each bridge, and it shall be attached to the ground rod in the junction box or lighting support adjacent to each end of a bridge.

**662.13.5-Service and Control Stations:** Grounding of all service and control stations shall be accomplished by means of a ground connector installed in the service cabinets where shown on the Plans and bonding all conduit ground bushings, metal casing of equipment, and neutral conductors by means of individual # 4 conductors, as elsewhere specified to the above mentioned

#### **662.14**

ground connector. The other ends of these conduits shall be bonded together and connected to the ground rod in the adjacent concrete junction boxes.

#### **662.14-TESTING:**

The Contractor is advised that before proceeding with any work under this Contract, the Contractor shall conduct the necessary continuity and insulation tests to establish the integrity of cable runs already in place. The Contractor shall report any cable fault found to the Engineer. In case any fault is located while contract work is in progress, and which has not been reported by the Contractor as prescribed, then the Contractor shall be responsible for the correction of any such fault without any extra compensation.

Continuity and insulation tests shall also be performed in a manner satisfactory to the Engineer on cable runs to be placed under this contract. The Contractor shall be responsible for the correction of any fault discovered.

With all equipment connected to the wiring system, a functional test shall be performed by the Contractor in the presence of the Engineer to demonstrate that the system as a whole and all parts thereof function as specified or intended. Any defective materials or faulty or improper installation shall be permanently corrected by repairs or replacements to be made by the Contractor to the satisfaction of the Engineer at no additional cost.

Lighting circuits shall then be subjected to such other tests as may be required, including additional insulation resistance testing as detailed in 662.9, and shall be the responsibility of the Contractor to perform these tests in the presence of the Engineer or authorized representative. All tests shall be performed at the expense of the Contractor.

After the installation is completed, the Contractor shall conduct a continuous 24-hour operating test for approval. In addition, final acceptance of an installation will not occur until 30 days of operation termed satisfactory by the Engineer.

During the 30 days of operation, the Contractor shall be responsible for repairing or replacing any defective equipment within 24 hours after being notified by the Engineer. After any malfunctioning equipment has been repaired or replaced, the 30 day test shall begin anew.

#### **662.15-METHOD OF MEASUREMENT:**

**662.15.1-Conduit:** Galvanized steel conduit and PVC conduit will be measured as a complete and operable conduit system on a lump sum basis per service.

**662.15.2-Manholes:** Manholes will be measured as a complete unit in place on a per each basis.

**662.15.3-Junction Box:** Junction Box Type A, B, C, H, or L will be measured as a complete unit in place on a per each basis.

**662.15.4-Luminaires:** Luminaires will be measured as a complete unit in place on a per each basis including lamp of wattage called for on the Plans.

**662.15.5-Cable:** Cable will be measured as a complete and operable cable system on a lump sum basis per service, including all connector kits necessary.

**662.15.6-Cable-in-Duct:** Cable-in-Duct will be measured as a complete and operable duct system on a lump sum basis per service.

**662.15.7-Lighting Supports:** Lighting supports will be measured per each per type furnished and installed, including support base and foundation as required for each support.

**662.15.8-Service and Control Station:** Service and control station will be measured as a complete and operable unit in place on a per lump sum per service basis.

**662.15.9-Incidental Electrical Work:** Incidental electrical work will be measured as a complete unit on a lump sum basis. Measurement of the unit will be based upon the amount of incidental work shown on the Plans and as necessary to complete the work.

**662.15.10-Electrical Tests:** Electrical tests will be measured as a complete unit on a lump sum basis per service, including all tests performed as required by the Plans and Specifications.

**662.15.11-System Modification:** System modification will be measured as a complete unit on a lump sum basis. Measurement of the unit will be based upon the actual amount of changes performed on previously installed systems as called for on the Plans and as necessary to complete the work.

**662.15.12-Navigation Lighting System:** Navigation lighting system will be measured as a complete and operable system in place on a lump sum per service basis. If the project requires temporary protection of any existing or new structure/substructure for an interim period of construction, all such temporary items/facilities shall be included in the pay item.

#### **662.16-BASIS OF PAYMENT:**

The quantities, determined as provided above, will be paid for at the contract unit price bid for the items listed below, which prices and payments shall be full compensation for furnishing all the materials and doing all work in a workmanlike and acceptable manner, including all labor, tools, equipment, supplies, and incidentals necessary to complete the work. All incidental work and materials for which no basis of payment is provided will be considered as completely covered by the prices bid for the items included in the contract.



**662.17-PAY ITEMS:**

<b>ITEM</b>	<b>DESCRIPTION</b>	<b>UNIT</b>
662002-*	GALVANIZED STEEL CONDUIT	LUMP SUM
662003-*	POLYVINYLCHLORIDE CONDUIT	LUMP SUM
662006-*	JUNCTION BOX , TYPE "type"	EACH
662007-*	LUMINAIRES	EACH
662008-*	CABLE	LUMP SUM
662010-*	LIGHTING SUPPORT, TYPE "type"	LUMP SUM
662013-*	SERVICE AND CONTROL STATION	LUMP SUM
662014-*	INCIDENTAL ELECTRICAL WORK	LUMP SUM
662015-*	ELECTRICAL TEST	LUMP SUM
662016-*	SYSTEM MODIFICATION	LUMP SUM
662020-*	NAVIGATION LIGHTING SYSTEM	LUMP SUM

\*Sequence Number

## SECTION 663

### PAVEMENT MARKINGS

**663.1-DESCRIPTION:**

Pavement markings shall consist of furnishing and installing various types of markings. It shall include, but is not limited to, edge lines, lane lines, barrier lines, channelizing lines, stop and crosswalk lines, stripes, curb marking, island marking, lane arrows, lane letters and raised markers, or combinations thereof, in accordance with Contract plans and the following specifications or as directed by the Engineer.

All details not specified or not shown on the Plans shall conform to the details and requirements set forth in the following publication:

The Manual on Uniform Traffic Control Devices for Streets and Highways, latest issue, as printed by the Federal Highway Administration, U.S. Department of Transportation. (Referred to as the MUTCD.)

**663.2-MATERIALS:**

Materials shall conform to the following Subsections of Division 700 of the Standard Specifications: